MICHIGAN ENVIRONMENTAL SCIENCE BOARD
CHLORINE PANEL

MEETING SUMMARY
WEDNESDAY, FEBRUARY 9, 1994
ROOM A-271, PLANT AND SOIL SCIENCE BUILDING
MICHIGAN STATE UNIVERSITY
EAST LANSING, MI

PANEL MEMBERS PRESENT:

Dr. Lawrence Fischer, Chair
Dr. Richard Cook
Dr. Raymond Demers
Dr. Bette Premo
Dr. Eileen van Ravenswaay

PANEL MEMBERS ABSENT:

None

BOARD STAFF PRESENT:

Mr. Keith Harrison, Executive Director
Ms. Shirley Willis, Administrative Officer
Ms. Patricia Fay, Secretary
Mr. Alex Morese, Student Intern

I CALL TO ORDER

Dr. Lawrence Fischer, Chair, called the meeting of the Michigan Environmental Science Board (MESB) Chlorine Panel to order at 1:07 p.m.

II EXECUTIVE DIRECTOR'S REPORT

Mr. Keith Harrison indicated that he had provided the MESB Chlorine Panel members with correspondence from Consumers Power Company regarding their use of chlorine and chlorinated compounds; additional copies of presentation material for 2 of the scheduled speakers; a listing of the articles transmitted to the Panel to date; and correspondence from the Ecology Center of Ann Arbor which transmitted additional chlorine literature for review and informed the Panel of a recent U.S. Environmental Protection Agency (USEPA) announcement to set up a task force to look at chlorine.

Mr Harrison stated that the Panel had been sent information previously concerning the proposed USEPA task force, and that the results from the MESB Chlorine Panel investigation would be shared with that federal agency once it was completed.

III PRESENTATIONS

Dr. John Giesy

Dr. John Giesy is a Professor in the Departments of Fisheries and Wildlife and Natural Science at Michigan State University. Dr. Giesy and five other independent experts were retained by CanTox, Inc. to assess the health and environmental impacts of chlorine. The work was done on behalf of the Chlorine Chemistry Council, which had requested a rigorous review of the scientific evidence for the position taken by Greenpeace, and later, the International Joint Commission, that all chlorine chemistry should be sunset.

Dr. Giesy stated that the CanTox panel consisted of experts in epidemiology, ecotoxicology, human health, and environmental fate. It reviewed the available literature on chlorinated compounds, then divided the compounds into product classes. They assessed the individual chemicals within classes, screening for those that seemed to need attention, i.e., were widespread in the environment, were known to cause problems, were considered contentious, or made good model compounds for a class. After the list was reduced to about 100 compounds, a complete analysis, including environmental fate modeling, ecotoxicology, epidemiology, and an analysis of human health effects, was conducted for each. Product life cycle assessments and risk benefit analyses were also completed. The CanTox panel also tried to target future uncertainties and research needs. They recognized that some chlorinated compounds have been environmental problems and tried to identify what information was currently available to help minimize possible recurrence.

The CanTox panel's approach was to look at structure-activity relationships. After determining the physical properties of organic compounds, particularly halogenated and, specifically, chlorinated compounds, the relationship between physical properties and known effects was examined. The same approach was used for examining environmental fate processes and biological activity in the environment, persistence, and bioaccumulation.

They concluded that chlorination of a chemical did not make it unique. Chlorinating compounds did not necessarily make them toxic or persistent. Chlorinated chemicals are not always bioaccumulated. Such properties depend on the structural properties of the compound. Neither is it true, as previously thought, that the more chlorinated a molecule the more toxic, persistent and bioaccumulative it is. Chemicals or classes of chemicals

should be assessed on their own merits. Assessments should be based on structural properties and should be based on sound scientific, toxicological or epidemiological evidence.

As specific examples, the CanTox panel looked at some of the issues in the pulp and paper industry, where chlorinated compounds, particularly the polychlorinated benzodioxins and dibenzofurans, are common. They found that removing chlorination from the process reduced dioxins, but it did not necessarily remove some of the toxic problems that had been attributed to dioxins. Those were actually the result of a number of natural products, phytosterols. The bottom line was that banning all chlorine technology was probably short sighted and would not address the real issues that need to be addressed for proper prevention and mitigation. Their final report, ***"Interpretive Review of the Potential Adverse Effects of Chlorinated Organic Chemicals on Human Health and the Environment***," has not yet been released.

Dr. Giesy also discussed the 4 basic assumptions underlying the work, which have been published as ***"Scientific Principles for Evaluating the Potential for Effects from Chemicals in the Environment,"*** in Regulatory Toxicology and Pharmacology, 18:313-356, 1993.

1. *The fate and biological activity of a compound are determined by the chemical properties of the compound.* The chemical and physical properties of compounds determine where the compounds go in the environment, how rapidly they get there, how much of the compound gets to a particular biological receptor, and what effect it has at that receptor. The process is mechanistically based. Chlorinated organic chemicals have diverse physical, chemical, and toxicological properties that affect their toxicity and fate, and cannot be categorized solely on the basis that they contain chlorine.

2. *Compounds do not show adverse effects below certain threshold concentrations, and above the threshold the magnitude of response is related to dose.* From all the information in the literature on chlorinated hydrocarbons, the CanTox panel could not reject the hypothesis that there was a dose response relationship for all of them. There was no absolute threshold, but on a response curve, on a probability basis, there was a point where an exposure did not cause effects that could be discriminated from the background.

3. *Inherent metabolic processes allow organisms to accommodate low doses of chemicals.* In the case of chlorinated organic chemicals, there are at least 1500 that have been found to be produced naturally. Organisms from diverse phylogenic backgrounds have evolved metabolic systems which can metabolize them without adverse effects. So, although it has been said that chlorinated compounds are synthetic and so are not able to be accommodated, that is not true.

4. *Observations associated with the presence of a certain compound must be biologically plausible effects, based on the specificity of the compound's activity in experimental*

systems. Associations are not necessarily cause-effect relationships. To determine cause and effect relationships between chemicals and adverse effects alleged through correlations in epidemiology or ecotoxicology studies, several other factors must be considered, including the strength of the associations, the reproducibility of the findings, the influence of any confounding variable, dose-response relationships, and temporal associations.

Dr. Fischer asked Dr. Giesy to comment on the IJC Task Force's identification of 7 or 8 of 11 problem chemicals found in the Great Lakes basin as organochlorines and their argument that chlorine as a class was a particular problem. Dr. Giesy responded that the identified chlorinated compounds did, in fact, turn out to be problems based on the CanTox panel's analysis and that chlorinated compounds, like others, have to be assessed rigorously before release. But the evidence indicated that not all chlorinated compounds are or will be problems. To say that many of them are among our past sins is not to say that we cannot in the future identify and avoid potential problems.

Dr. Premo, noting that when chlorine is used as a feedstock in any manner, certain percentages of harmful chlorinated organics will be created, asked Dr. Giesy whether the group looked at control of the harmful compounds after they were created. Dr. Giesy responded that although such substances are created in the processes, it did not matter whether the substance was chlorinated or not. All chemicals and compounds, chlorinated or not, should undergo rigorous life-cycle assessment prior to manufacture and use to look for potential adverse effects, with risk/benefit analyses. With such testing required, the marketplace will be the appropriate mechanism for controlling substances, since it may be too expensive to test all chemicals rigorously up front. It was the CanTox panel's conclusion that it was probably better to let the marketplace answer those questions than to just ban the entire chlorine technology now.

Dr. van Ravenswaay asked what specific alternatives the CanTox panel looked at in the pulp and paper industry and how they compared risks - using two different alternatives or comparing each different technology. Dr. Giesy responded that they reviewed recent information from Canadian laboratories looking at paper mills before and after changing to chlorine dioxide. Other research has involved looking at the potential for using ozonization as opposed to chlorination. Ozonization does not seem to be the solution. Research shows that the lignin in the wood becomes hydroxylated, and can form fairly persistent estrogenic compounds. Again, it is important to look at all the effects of every alternative process, so that they can be understood and mitigated if necessary.

Dr. van Ravenswaay asked if Dr. Giesy could define the data gaps relating to alternative technologies. He answered that all chemicals should be analyzed prior to use. Currently,
insecticides, for instance, go through fairly rigorous testing; however, most other compounds and products currently do not. He thinks that much can be done with the kind of model that was used for the CanTox study - some structure-activity relationships, fairly simple laboratory studies and models to estimate where things will go, how persistent they will be, and what effects they will have.

Dr. van Ravenswaay asked Dr. Giesy what kinds of studies need to be done. He replied that it would be easy to say that a lot of specific toxicological testing would be needed. But he is biased toward looking at classes of compounds and deriving relationships that would help in understanding the big picture instead of running simple tests on each chemical. Fragment additive models can be built up from pieces and predict fairly accurately. The weakness of these models is the toxicological receptor mediated side, which gets very complex. In addition, there are some cases where there is not enough information available for good modeling, such as tertiary amines. He would prefer that effort go into filling in gaps in the modeling process rather than repetitive, but inadequate, testing of each chemical. The Michigan Department of Natural Resources Critical Material Registry staff reviews large numbers of chemicals. That is a mechanism through which such models could be applied to identify chemicals that could be potentially problematic.

Dr. Robert Soderstrom

Dr. Soderstrom is the Chairperson of the Michigan State Medical Society's Task Force on the Environment and Health. Dr. Soderstrom presented background on the Michigan State Medical Society's position on the IJC's recommendation on chlorine. A copy of Dr. Soderstrom's discussion material is presented in Attachment 1.

Dr. Demers asked if the medical profession has been able to document reasons for the observed infertility. Dr. Soderstrom responded that it had not; infertility can occur on a number of bases. Sometimes it can be anatomical, sometimes it is because of a low sperm count, and sometimes the reasons cannot be ascertained at all. The medical profession is hearing more frequently of low sperm counts and some investigators are hypothesizing that this is due to estrogen-acting chlorinated hydrocarbons. However, there is a lot of infertility for which there are no answers.

Dr. Fischer asked if Dr. Soderstrom believed that the pharmaceutical industry and water chlorination needed to be exempted from the IJC's sunsetting recommendation. Dr. Soderstrom stated that it was his understanding that the contamination to the Great Lakes from the pharmaceutical industry and water chlorination was small. However, he felt that even that contribution should be looked at and, if there were substitute ways to make certain drugs or rid water of pathogens without using chlorinated compounds, then the substitute ways should be used. If substitute ways cannot be found then these 2 areas should be exempted.

Dr. Fischer stated that Dr. Giesy had mentioned the need to identify the thresholds where a given chemical exerted a biological effect. Dr. Fischer asked how Dr. Soderstrom felt about the threshold question. Dr. Soderstrom indicated that when you talk about thresholds, you have to look at the whole human continuum and be concerned about the fact that we are so different genetically, and that you may well have subsets of people who are genetically susceptible to a problem and, therefore,

defy the threshold. A given level may be okay for him and most of the people in a bell-shaped curve, but it may be a disaster for the people that are out at the ends.

Mr. Harrison asked if a threshold concept was not used, what would be used in its place, or would a broad ban across everything have to be imposed. Dr. Soderstrom indicated that a broad ban would need to be imposed. For instance, we know that smoking 2 cigarettes is better than smoking 20, but smoking 2 cigarettes is not healthy. Therefore, you should not smoke at all.

Dr. Premo stated that there is such a thing as defining the threshold from the most susceptible of the group in question. For example, using the fetus to define the threshold value for the human population. Dr. Soderstrom expressed concern about the ethical problems of exposing human embryos to define the threshold.

Elizabeth Harris, East Michigan Environmental Action Council, asked Dr. Soderstrom if he had any comment on a report presented in the "Washington Post" this January which suggested that there has been a 50 percent sperm drop, worldwide, between 1938 and 1990. Dr. Soderstrom indicated that he did not know anything more than what she had read; however, he has seen in some technical journals in the last two or three weeks, the idea that spermatogenesis may be impaired embryologically. Also, there is some evidence in wildlife that bathing these cells in estrogen-acting compounds impairs their development. Therefore, males are born with an inadequate number of cells to produce an adequate number of sperm. While much of this is new and rather speculative at this time, there nonetheless is wildlife research that supports the idea.

Dr. Ross Hume Hall

Dr. Hall is a Professor Emeritus of Biochemistry at McMaster University Health Sciences Facility. He co-chaired the 1989-92 Human Health Committee of IJC Science Advisory Board, and is currently serving on the IJC's Ecosystem Health Workgroup. Dr. Hall presented a discussion on how the IJC's Human Health Committee approached and answered the question regarding the impact of organochlorines and persistent chemicals on human health. His presentation is summarized in Attachment 2.

Dr. Demers asked if studies that do not reach a statistically significant conclusion get incorporated into the weight of evidence approach. Dr. Hall answered that such studies would be part of the weight of evidence. They would receive equal consideration if they were in a valid publication.

Dr. Demers stated that the reason he asked is that negative studies tend not to get published as easily as positive studies, and there may be a bias inherent in this approach because of the extra weight given to published positive studies.

Dr. Fischer asked Dr. Hall if the IJC Human Health Committee looked at all the studies and gave weight to them based upon the quality of the research and science. Dr. Hall

stated that the committee did not and, in fact, tried to avoid looking at studies in isolation. At the same time, however, they did try to take into account the quality of the research. The committee was composed of many experts, and many additional experts were brought in by the committee. As a consequence the committee was able to make some expert judgments on the papers.

Dr. Premo asked Dr. Hall if he felt that the manner in which Dr. Giesy was using weight of evidence was similar to the way the IJC used weight of evidence. Dr. Hall answered no; Dr. Giesy's approach was classic toxicology and epidemiology, and that is fine as far as it goes. But he did not think, in terms of the problem that faces us, that it was adequate. Dr. Hall continued that he did not think Dr. Giesy's group was bringing in aspects that the committee brought in, like the basic biology and looking at reasonable effect based on what is known of basic biology. He did not feel that they were bringing in enough of the human biology or animal biology and looking at that in relationship to the chemical and toxicological information. Dr. Premo stated that Dr. Giesy did refer in his presentation and in his literature to the estrogenic and biological effects that were considered. And she wondered if Dr. Hall felt that Dr. Giesy's presentation and his group had what Dr. Hall would consider a biological understanding of the effects. Dr. Hall stated that in all fairness, he had not read their report; rather, he had only heard their presentations at the IJC meeting in Windsor.

Dr. Fischer asked if Dr. Hall was saying that he believed that chlorinated compounds represented a particular problem because of their estrogenicity and if it was more likely that chlorinated compounds show estrogenic activity than non-chlorinated compounds. Dr. Hall answered yes, organochlorines are of concern not just because of their estrogenic properties, but also because they bioaccumulate and are persistent.

Dr. Hall indicated that Theo Colborn recently published a paper, Environmental Health Prospectus. In it, she identified 42 single compounds and classes of compounds, environmental pollutants, that have known estrogenic properties. Of that 42, over half were organochlorines. In terms of toxicological power, he felt that the identified organochlorines would probably dominate the entire spectrum of estrogenic compounds.
Dr. Fischer asked about the many natural substances present in food which are also estrogenic in nature. Dr. Hall indicated that the human and animal body can digest or metabolize the natural sterols, but it cannot metabolize PCBs; the PCBs permanently interact with the estrogen receptors.

Mr. Mel Visser

Mr. Mel Visser is the Vice President of the Environmental Quality Division for the Upjohn Company. Mr. Visser presented a discussion on some of the policy issues associated with the chlorine question. Mr. Visser's presentation is summarized in Attachment 3.

Dr. Cook asked Mr. Visser what he would say to the Chlorine Panel or others to assure them that the issues that they were talking about today would not become the concerns that will be pointed out 10 years from now saying well, of course, we all agree that these chemicals are bad, etc. Mr. Visser stated that it is difficult to respond, and that he would need to defer that question to some of the experts following his presentation.

Mr. Such introduced Dr. George Werezak, Director of Environmental Health and Safety with Dow Chemical Canada. Dr. Werezak served on the IJC's Virtual Elimination Task Force. He presented information regarding the process used by the Task Force in reaching their conclusions on chlorine. Dr. Werezak's presentation is summarized in Attachment 4.

Dr. Fischer asked about the amount of agreement between the members on the Virtual Elimination Task Force regarding the chlorine ban/sunsetting issue. Dr. Werezak responded that the Task Force had a difficult problem dealing with the recommendation and finally concluded with the recommendation that he quoted in his presentation. But at no point did they vote on whether or not they agreed with it. The Task Force tried to work by consensus. It was recognized that there was substantial disagreement between the proponents for a chlorine ban and others who felt that this was a premature call. So the chair deliberately avoided taking a vote on the issue and tried to find some middle ground, which was the material that was published.

Dr. Fischer asked about the relationship between the Virtual Elimination Task Force and the people who wrote the IJC Sixth Biennial Report. Dr. Werezak stated that some of the recommendations of the Task Force were cited in the Sixth Biennial Report as evidence. But none of the Task Force members sat on the writing committee for the Sixth Biennial Report. The way the IJC wrote its final report was to accept all of the reports of its various committees and then write its own report, retaining total accountability for what was in the document.

Dr. Hall elaborated that there was a formal structure within the IJC. For instance, his Health Committee was part of the Science Advisory Board. Their report went to the Science Advisory Board, which in turn issued a report that went to the 6 IJC commissioners. In Dr. Werezak's group, the Virtual Elimination Task Force, their report also went up. In addition to this formal structure, the commissioners often would talk informally with some of the committee members. As a consequence, there was a kind of informal information flow between the commissioners and the individual members of these groups. The actual writing of the Sixth Biennial Report was done by the 6 commissioners and their staff.

Mr. Dale Phenicie, Georgia-Pacific, stated that the chair of his task force had in fact written to the IJC after the Sixth Biennial Report came out and expressed dismay and concern over the fact that the recommendation to sunset chlorine had really been made before the Task Force work had been completed.

Mr. Dale Phenicie

Mr. Dale Phenicie is the Manager of Environmental Regulatory Affairs for Georgia-Pacific. Mr. Phenicie has degrees in industrial chemistry and paper and pulp technology from Ferris State University and Western Michigan University. He is the Chairman of the American Forest and Paper Association Great Lakes Task Force, and also was a member of the IJC's Virtual Elimination Task Force. Mr. Phenicie presented information on chlorine compounds in the pulp and paper industry. Mr. Phenicie's presentation is summarized in Attachment 5.

Dr. Cook asked if the multi-colored chart presented by Mr. Phenicie accounted for the ultimate fate of all chlorine used in the process. Mr. Phenicie answered no; they charge fewer atoms of chlorine in the chlorine dioxide process than they do the other. The unused chlorine atoms go out as inorganic chlorides or other materials not associated with the chlorinated compounds that they are concerned with.

Dr. M.J. Pcolinski, Michigan Chemical Council, elaborated that when elemental chlorine is used in the process, hydrophilic, acidic, polar fractions, phenolics, neutrals and volatiles are formed. When ClO_2 is used in that process, the products that are produced do not contain chlorine, but they are still acidic, and some of them are still volatile, some are polar, and some are hydrophilic. So what is being shown are the products that are produced using ClO_2 which in themselves do not become chlorinated, so that when a separation and an extraction is done of those fractions, the use of ClO_2 minimizes the number of chlorinated compounds produced. It has no bearing on the number of chlorines contained.

Dr. Fischer asked if the products of the oxidation that arise from the use of chlorine dioxide had been characterized and, in particular, tested for toxicity in the same manner as the chlorinated products. Mr. Phenicie answered that they run toxicity tests on pulp mill effluents. Based on those tests they do not have a toxicity problem.

Dr. Fischer asked if the toxicity tests used were capable of detecting receptor mediated and hormonal events. Dr. Jim Bus, Dow Chemical, responded that the current toxicology tests do detect these kinds of subtle parameters. There are chronic lifetime studies that extensively characterize animals not only for cancer effects, but also for toxic effects. In addition, two-generation reproductive tests are conducted where animals are exposed to the chemical, bred, exposed to the chemical again, and bred again, thereby looking at the effects of the compounds over multi-generations.

Genetic toxicology tests and, on some occasions, tests using suspected hormonally active-compounds are also conducted. Biochemical tests and medical clinical chemistry tests are used also that allow a more detailed characterization of the effects of the compounds. As a consequence, Dr. Bus contended that current toxicological protocol by and large does capture that potential effect, and can pick up on the subtle toxicological end points, like reproductive effects.

Dr. Fischer asked about the disposal of sludge. Mr. Phenicie stated that most of the sludge goes to landfills. However, alterative uses are being explored such as spreading it on farm lands or in forest lands as soil conditioning.

Tracy Easthope, Ecology Center of Ann Arbor, asked if Georgia-Pacific had done caged fish studies from the effluent of chlorine dioxide processing. Mr. Phenicie answered that in their research facility in North Carolina they have two experimental streams. They are not caged fish, rather they are stream impounded fish. Effluent is run through one side and mixed with river water. Plain river water is run through the other side. The health of the fish is evaluated in both of the streams. Thus far, they have not seen detrimental effects. Ms. Easthope asked if they looked at the buildup of compounds. Mr. Phenicie indicated that they have but he did not have the data. He indicated that he would provide the information, however.

Dr. Ralph Morris

Dr. Ralph Morris is the Executive Director of the Galveston County Health District in Galveston, Texas. Dr. Morris is a physician and has been practicing public health and preventive medicine for the past 12 years. Dr. Morris has a special interest in environmental health issues and their impact on the public. Dr. Morris talked about the public health implications of the IJC recommendation on chlorine. Dr. Morris's presentation is summarized in Attachment 6.

Elizabeth Harris, East Michigan Environmental Action Council, asked which countries in Europe use processes other than chlorination for their water. Dr. Morris answered that several European countries use chlorine dioxide and some ozone, however, he did not have any specifics as to which ones.

Ms. Easthope asked if there were some European countries that did not use chlorine at all. Dr. Morris answered that he did not have any knowledge of that; but, the by-products of not using chlorine were not nearly as well studied or understood.

Ms. Easthope asked if Dr. Morris could comment on the fact that there have been infectious agents that have gotten by chlorinated systems. Dr. Morris answered that he did not want to intimate that chlorine worked for all infectious agents. There are a variety of different agents, particularly non-bacterial, that are either partially or not at all affected by the use of chlorine. In terms of safe drinking water, this country uses multiple barriers and methods to ensure that its water is safe.

Dr. William Salmond

Dr. William Salmond is the Vice-President for Chemical Operations for the Upjohn Company. Dr. Salmond received his Ph.D. in organic chemistry from the University of St. Andrews in Scotland. He also completed post-doctoral studies at the University of

Cambridge, England, and E.T.H. in Zurich, Switzerland. Dr. Salmond presented information regarding chlorine and the pharmaceutical manufacturing business. Dr. Salmond's presentation is summarized in Attachment 7.

Dr. Cook expressed concern about Dr. Salmond's inferences that Upjohn's processes were very targeted reactions, and the materials coming out were well characterized. He would presume that Upjohn has many reaction products which end up in an organic or mixed waste streams, and eventually in their hazardous waste incinerator. He stated that he was also concerned by the characterization that the processes end up with inorganic chlorine in the form of chlorine ions.

Dr. Salmond stated that they spend an enormous amount of time in the analytical scrutiny of compounds, both for the purity of the compound itself and the by-products produced. The Federal Drug Administration demands to know what the by-products are in the reaction.

Dr, Demers asked if he could be provided with a list or a reference for a list of pharmaceuticals by class identifying non-chlorinated alternatives. Dr. Salmond indicated that he would try to obtain one.

Dr. Fischer asked Dr. Salmond if he could provide the Chlorine Panel with data which would back up the claim that only chloride ions are the by-products of many of their processes. Also, Dr. Fischer asked if he could be provided the protocol used to examine
the components of mixture that are to be discarded. Dr. Salmond answered that he would provide the information.

Dr. Ron Whitfield

Dr. Ron Whitfield is the Vice President of Charles River Associates. Dr. Whitfield authored the recent Charles River Associates report on the benefits of chlorine chemistry in the United States and Canada. He earned his Ph.D. in Business and Applied Economics at the University of Pennsylvania. Dr. Whitfield presented Michigan-specific data on chlorine economics. A copy of Dr. Whitfield's discussion material is presented in Attachment 8.

Dr. van Ravenswaay asked for a clarification regarding how long Dr. Whitfield assumed it would take for the chlorine substitution to take place. He stated that Charles River Associates discussed whether they needed to consider the transition period or not. Given their timetable, which was to complete the report in 4 months, it was decided to provide just two snapshots. The transition, however, would be long requiring a great deal of investment, because of the pervasive nature of chlorine chemistry.

Dr. van Ravenswaay asked if the Charles River Associates' analysis assumed that there would be no salvage value; and what other assumptions or constraints did they base

their numbers on. Dr. Whitfield stated that, in general, there may be some salvage value but they did not consider it. For instance, PVC plants or PVC fabrication plants might have some injection molding equipment that might be transferable to some other kind of plastic. For large scale operations such as the large chloroalkalide plants, there is not much else that can be done with some of those facilities. The plastics fabrication equipment may be more transferable as a new asset to fabricate other kinds of plastics.

Dr. Whitfield stated that their study did not consider life cycle, total product costs or the cost of a transition, if one was necessary. There would be expected dislocations, but they did not try to increase their estimates because of dislocation problems. They did not include the macroeconomics effect of a 100 billion dollar tax on consumers. Consumers would have to pay more money to buy basically the same basket of goods and services; which usually has feedback effects. Therefore, their numbers are understating the true impact of the chlorine phase out.

Dr. Whitfield stated that they also did not try to make trajectories of normally occurring consumer preferences. Consumers are always changing their purchase patterns; so they did not try to look at some of the quantitative health risks and environmental impacts. In addition, they did not try to estimate indirect costs of infrastructure and new power plants. All the previously mentioned costs were left out of the equation just to be on the conservative side.

Dr. Premo asked if the Charles River Associates' analysis included any factors which might result in their overestimating the costs; for instance, rising costs of regulatory procedures. Dr. Whitfield answered no.

Dr. Fischer asked how Dr. Whitfield assigned a dollar value to the benefit of using chlorine free substitute products. He answered, using as an example, PVC, which is a widely used plastic for pipe for drain waste and vent irrigation pipe fittings and other products. They estimated the amount of PVC consumption for each application. For pressure water pipe it would be 700,000 tons consumed. This application currently competes against ductile iron, copper, and high density polyethylene. Within each one of these, they estimated the current market share and the basis for the competition between PVC and the other products. They estimated how much new investment would be required to build additional capacity were PVC not available. Because ductile iron is heavier than PVC, there would be a big installed cost penalty to install a foot of PVC pipe versus a foot of ductile iron pipe. They did not assume that they were equivalent on an installed cost basis. The manufacturing cost difference, the capital cost difference, the cost associated with new capacity, and the installed cost differential were added to get to the same level of performance. The resulting cost is the estimated incremental cost of substitutes to replace the PVC pressure water pipe with a combination of what is currently available in the market today.

Dr. van Ravenswaay asked if Charles River Associates looked into how much costs vary in the natural resource-seeking markets for copper and iron. Dr. Whitfield

answered that they did, and the costs and prices used in their analyses were representative of a normal market.

Dr. van Ravenswaay asked if the markets were large enough for the substitutes; i.e., did they have competitive structure or economies of scale. Dr. Whitfield answered that in the plastics area, there appeared to be ample capacity to add more volume. But in order to get the ductile iron production up, additional capacity would need to be added. Additional capacity would not have to be added for every single competitive product. In addition, to encourage investors to come into the market, they have to earn a return on capital. Where there was excess capacity, for example, in copper or polyethylene, they did not assign any capital cost to that incremental production. They also assigned a penalty for the higher cost of the product on an installed basis, if there was such. In a couple of cases, they found it was cheaper, but that was the exception, not the rule.

Dr. Demers asked Dr. Whitfield if he could provide additional data on the chlorine-containing drug analysis. Dr. Whitfield indicated that he would supply the data.

Dr. James Bus

Dr. James Bus is the Research Manager of General Toxicology and Chemistry for Dow Chemical. Dr. Bus is an Adjunct Professor in the Department of Pharmacology & Toxicology at Michigan State University. He was educated in Michigan, earning his B.S. in Medicinal Chemistry at the University of Michigan and his Ph.D. in Pharmacology at Michigan State University. Dr. Bus discussed the toxicology of chlorine and chlorinated compounds. Dr. Bus's presentation is summarized in Attachment 9.

Tim Eder, National Wildlife Federation, asked once it is known that there is a given mechanism of reaction for a given compound, how is it determined that there are not other mechanisms of reaction that may occur later. Dr. Bus answered that one mechanism may drive cancer, another mechanism may describe an acute effect, such as a neurological effect. Current toxicologic evaluations are designed to characterize those potential different mechanisms as they may occur.

Ms. Tracy Easthope asked if Dr. Bus would comment on the USEPA's data on dioxin. It was her understanding that the scientists who have been working on it are saying that they have not found a threshold for effects from exposure to dioxin. Dr. Bus answered that that was an issue of contention. Risk assessment, with respect to dioxin, will be controversial for years to come; however, that does not mean that science and the discipline of toxicology cannot provide those answers.

IV PANEL MEMBER ASSIGNMENTS

Chlorine Panel member assignments were not made.

V. PUBLIC COMMENT

Dr. Holcomb, Vice President of Holcomb Environmental Services, indicated that, when he was with the Toxic Substance Control Commission, they had looked at similar toxic related issues. Information was reviewed in terms of health risks, whether it is cancer or non-cancer related. He indicated that about 3 years ago he began informing his clients that the investigative trends would shift from cancer to neurological, reproduction and developmental problems. As a consequence, his service has created a data base on bioaccumulation, and has some 1400 computer-based articles on bioaccumulation of dioxins and dioxin-like compounds, including PCB.

Dr. Holcomb indicated that two documents have been recently completed by his service -one on the reproductive and developmental health risks from dioxin-like compounds, and the other on cancer risks of dioxin and related compounds. They have looked at the compounds and their concentrations in the environment. Dr. Holcomb indicated that the evidence for impact on animals, including invertebrates and humans, is paramount. In reviewing data sources, they looked at a comparison of the daily doses that animals in the
environment, including people, would get in estimated body burdens from the positive epidemiological animal studies and then looked at background environmental doses. A review of these data show that there is a big gap between the environmental doses for dioxins compared to the doses that are seen in the epidemiological and animal studies. That gap is usually between 100- to 1,000-fold between the lowest observable adverse effect level, whether it is cancer or an acute or chronic effect, and what actually occurs as an environmental dose in the field. The exceptions are where there is a specific point source, such as for PCB and dioxins. Despite this, he pointed out that there are data now to show that overall PCB and dioxin levels are going down. In addition, and again except in specific situations where there is a point source, there is also no evidence of an adverse environmental or health effect on animals and invertebrates resulting from known contaminant levels in the environments.

Ms. Isabella Tucci asked for comments regarding Michigan's proposal to build retention treatment basins to solve the combined sewer overflow problem in its rivers. Dr. Holcomb commented that due to the highly diluted medium, there would be a very low concentration of chlorinated compounds as a result of that operation.

Ms. Tracey Easthope commented that there was anecdotal evidence that dioxin levels in the Saginaw Bay area are going up, pointing out that 5 of 5 large trout tested above the Michigan Department of Public Health trigger level for dioxin. She also stated that by-products, such as dioxins, are produced with most chlorinated compounds and that there appears to be an important connection between the production of chlorinated compounds and combustion, in that the land ban has resulted in more chlorinated compounds being incinerated. She indicated that there will be action on chlorine at the national level, and that Michigan industries could get a head start.

Dr. Salmond stated that he would disagree with the statement that in most chlorinating chemical reactions dioxins are produced. He indicated that Upjohn Company has conducted many different reactions involving either chlorinated or chlorine-containing compounds where dioxins were not formed.

VI NEXT MEETING DATE

The next meeting date of the MESB Chlorine Panel was not established at the February 9, 1994 meeting (The date for the next MESB Chlorine Panel meeting has been subsequently established for March 3, 1994).

VII ADJOURNMENT

The meeting was adjourned at 5:37 p.m.

Keith G. Harrison, M.A., R.S., Cert. Ecol.
Executive Director